# RESEARCH CLUSTER N: Nanostructured Materials

## Cluster Co-Leaders: Kenneth Carter and Ryan Hayward

Cluster N focuses on fabrication and characterization of polymer-based nanostructured materials. The expertise and interests of participants include molecular design and synthesis of polymers and nanoparticles, self- and directed-assembly of complex nanostructures, characterization of unique structures and properties of nanoscale materials, and development of state-of-the-art approaches to nanolithography. The combination of polymers and nanoparticles with diverse properties into hierarchically organized materials with precisely controlled structures provides unprecedented opportunities to tailor properties ranging from mechanical to magnetic to optical. The broad interests of this cluster include: photonics, membranes (separations or selective transport), magnetic storage, optoelectronics, displays, sensors, energy (harvesting and storage), nanomedicine, and adaptive or self-healing materials.

This cluster connects industry to nanotechnology research efforts within several departments—Polymer Science and Engineering, Chemistry, and Physics—and multi-investigator centers at UMass—the NSF Materials Research Science and Engineering Center (MRSEC), the Center for Hierarchical Manufacturing – an NSF Nanotechnology Science and Engineering Center (NSEC), and the DOE Energy Frontier Research Center - Polymer-Based Materials for Harvesting Solar Energy (PHaSE).

### Polymer/nanoparticle hybrid assemblies

- Tailored assembly of inorganic nanoparticles (NPs) using custom polymer ligands and external fields
- Jamming of NPs to kinetically arrest co-continuous structures for membranes and photovoltaic devices
- Preparation of delivery vehicles including crosslinked NP fibers and capsules and NPs encapsulated in amphiphilic assemblies
- "Smart" materials and sensors via NPs with responsive and switchable interactions

### Nanoscale surface instabilities

- Extending elastic instabilities to the nanoscale
- "Bottom-up" patterning through instabilities for tailored surface properties (optical, adhesive, bioactivity, etc.)
- Adaptive and self-cleaning materials
- Rapid delivery at interfaces by uncrumpling of nanosheets

### Assembly of nanoconfined block copolymers

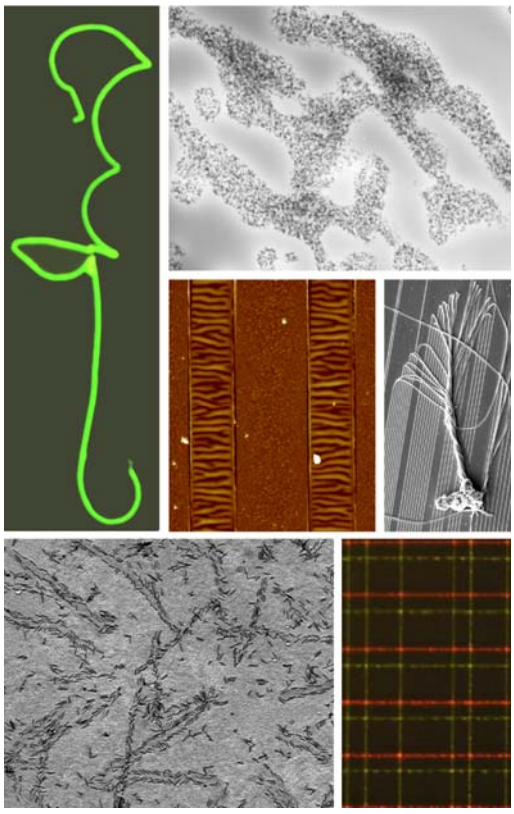
- Fabrication of novel nanostructures via self-assembly of functional block copolymers under 1-, 2-, and 3-D confinement
- Perfection of ordering in thin films using reversible transitions
- Templating of inorganic and biomolecular nanostructures

### Nano-optoelectronic materials

- Synthesis and assembly of optoelectronic nanostructures based on polymers, small molecules, and nanoparticles
- Characterizing photophysical behavior of single nanostructures
- Fabrication and testing of unique device architectures

### Advanced nanolithographic fabrication

- Research on new materials and processes for nanoscale precision patterning: high resolution resists, self-assembled templates, and electrochemical deposition within nanoimprinted features
- State of the art facilities for nanoimprint, electron-beam and photo-lithography
- Integration of novel materials with real-world device fabrication



Unique nanostructured materials fabricated by Cluster N researchers include crosslinked NP fibers (top left) and grids (bottom right), jammed bicontinuous polymer/NP blends (top right), wrinkled imprinted films (center), hybrid organic/inorganic fibrils (lower left), and electrodeposited wires within nanoimprinted templates (middle right).

### Contact Information

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